

LIFE HISTORY INFORMATION

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2013 PIFSC External Review of Data for Stock Assessments

25 June 2013

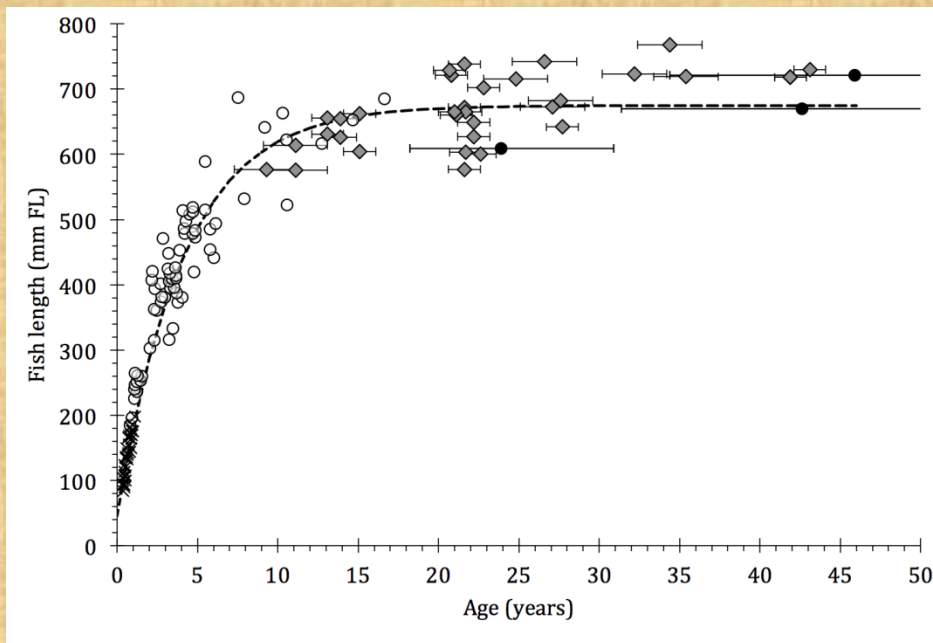
LIFE HISTORY INFORMATION

Goal: to provide accurate life history parameters in support of stock assessment & management.

Primary Information:

- Length-at-age growth curves
- Longevity estimates
- Length at median (50%) reproductive maturity

Opakapaka, *P. filamentosus*



FISHERIES & TARGET SPECIES SAMPLED

SAMPLING LOCALES: Hawaii, American Samoa, Commonwealth of the Northern Marianas (CNMI), Guam

Hawaii-based Pelagic Longline Fishery:
Striped Marlin



Primarily Hawaii-based Bottomfishery:
Eteline snappers (7 species)
Groupers (1 species)



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FISHERIES & TARGET SPECIES BIO-SAMPLED

Coral Reef Fisheries in the Pacific Regions (American Samoa, CNMI & Guam):

Emperors - Lethrinidae (4 species)

Goatfish - Mullidae (1 species)

Groupers – Serranidae (1 species)

Snappers – Lutjanidae (3 species)

Soldierfish – Holocentridae (5 species)

Surgeonfish – Acanthuridae (1 species)

Wrasses & Parrotfish – Labridae (3 species)



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DATA & SAMPLE COLLECTION NEEDS

Specimen Sampling Needs: For each species sampled,
1) Access to a range of sizes throughout the year, and
2) Availability of both immature and spawning individuals

Life History Sample Needs:

Body length & weight

Gonad weight

Species identification

Otoliths

Gonad subsample

Fin/muscle tissue



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COLLECTION OF DATA & SAMPLES: HI-Based Pelagic Longline Fishery

Specimen Sampling: Exclusively fishery-dependent
for striped marlin



Biological Sampling Procedures:

1. At-sea sampling by trained PIRO contracted observers
 - Observers sample according to written protocols
 - ID species and measure length (EFL)
 - Collect/preserve/label head, fin spines, and gonads



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COLLECTION OF DATA & SAMPLES: Primarily HI-Based Bottomfish Fishery

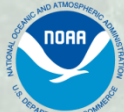
Specimen Sampling:

Both fishery-dependent & fishery-independent for eteline snappers & epinepheline groupers



Biological Sampling Procedures:

1. Directed sampling via NOAA research vessels
 - At sea measurements, gonads preserved, heads frozen
2. Sampling of fish markets & cooperative fishers
 - Opportunistic sampling, capture date uncertain
 - Provides rarely collected juveniles & large adults



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COLLECTION OF DATA & SAMPLES: Pacific Regions – Coral Reef Fisheries

Specimen Sampling: Exclusively fishery-dependent for about 17 targeted coral reef fish species



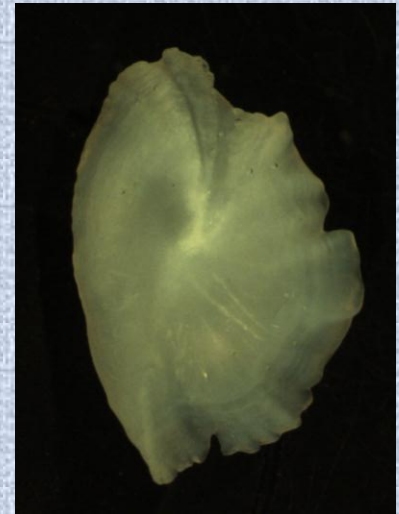
Biological Sampling Procedures:

1. Contracted bio-sampling teams in each Pacific region
 - Primarily recording length & weights of species
 - Secondly purchasing select species for life history
 - Extract otoliths & gonads, weigh gonads
 - Store otoliths, subsample/preserve gonads, database entry
 - Otoliths & gonads shipped back to PIFSC

LAB PROCESSING OF OTOLITH SAMPLES: Annual Growth Marks

Traditional Otolith Processing for Age Determination by Growth Mark Counts:

1. Otoliths weighed, measured & sectioned in-house or by fish ageing contract service
2. Sections cut thicker for visualizing annual growth marks
3. Thin sections require extra grinding/polishing to enhance visibility of daily growth increments (DGIs)
4. Processing: 5 otoliths/day for annuli; 1 otolith/day for DGIs; need ~20 otoliths/per size class/sex/species



LAB PROCESSING OF OTOLITH SAMPLES: Radiochemical Dating

Otolith Processing for Longevity & Age Validation

1. Bomb Radiocarbon ($\Delta^{14}\text{C}$) Dating

- Otoliths ground; 3 mg of core extracted
- Prep work: 1 otolith/day; 20-30/species
- Samples sent to Woods Hole for analysis



2. Lead-Radium ($^{226}\text{Pb}:^{210}\text{Ra}$) Dating

- Otoliths sculpted down to juvenile dimensions; like sized fish pooled ($n \sim 15$) to provide the ~ 1 g needed for analysis
- Prep work: 1 otolith/day; 45-75 otolith preps per species
- Samples sent to UH Geochemistry Lab for analysis



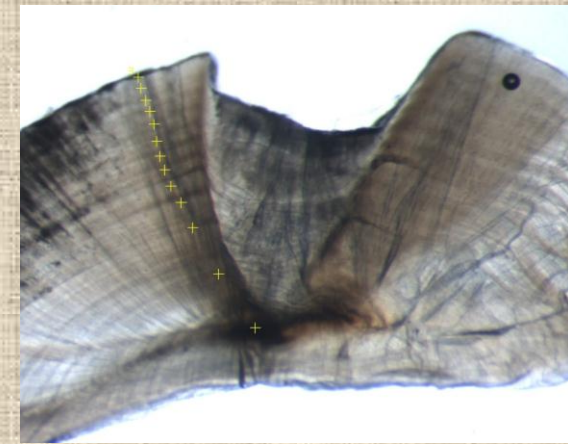


LAB PROCESSING OF GONAD SAMPLES: Histology

Laboratory Processing for Maturity Determination:

1. Gonad subsample fixed in the field, preserved at least 3 month, then sent to UH Med School for histology prep
2. Histology slides received back are stained thin-sections mounted on glass slides ready to be evaluated
3. Histology processing: ~3 weeks/200 fixed gonads; need 20 histology slides/size class/sex/species

ANALYSIS OF OTOLITHS: Growth Mark Age Determination



Lab Analysis:

1. Hi-power microscope counts of DGIs (thin sections)
2. Low-power counts of presumed annuli (thick sections)
 - If possible, DGI data used to identify first annulus
 - Measurements from core to successive annuli & edge
 - 2 age readers, 3 blind counts per otolith, 10-20 otoliths/week

Data Analysis:

1. Variance of within-/between-reader age estimates assessed
2. Back-calculated ages generated
3. von B growth function generated from mean length-at-age data



ANALYSIS OF OTOLITHS: Bomb Radiocarbon $\Delta^{14}\text{C}$ Dating

Analytical Assumptions:

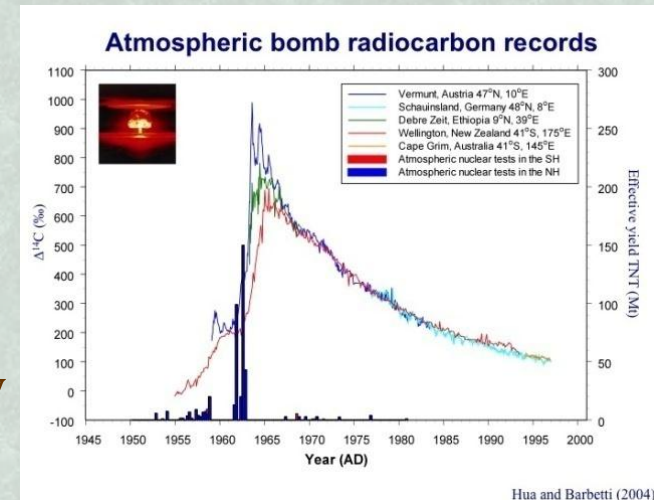
1. ^{14}C in otolith core fixed at deposition
2. Regional $\Delta^{14}\text{C}$ coral reference series

Lab Analysis:

1. $\Delta^{14}\text{C}$ measured at Woods Hole facility

Data Analysis:

1. $\Delta^{14}\text{C}$ values corrected for natural isotopic fractionation ($\delta^{13}\text{C}$)
2. $\Delta^{14}\text{C}$ values projected back onto regional coral reference series to derive birth year
3. Auxiliary age data used to determine whether birth year coincides with rise or decline portion of $\Delta^{14}\text{C}$ reference series
4. Analysis time: 2-3 months per batch; 20-30 otoliths/species



Hua and Barbetti (2004)

ANALYSIS OF OTOLITHS: Lead-Radium (^{226}Ra : ^{210}Pb) Dating

Analytical Assumption:

1. ^{226}Ra and decay series is a closed system within otolith cores

Lab Analysis:

1. At UH Geochemistry Facility; 3 months time/pooled sample

Data Analysis:

1. Age calculation based on ^{226}Ra & ^{210}Pb measurements
2. Correction factors applied to measurement values
3. Intercept of corrected measurement values with ^{226}Ra : ^{210}Pb in-growth function provides final age estimates up to 100 yr



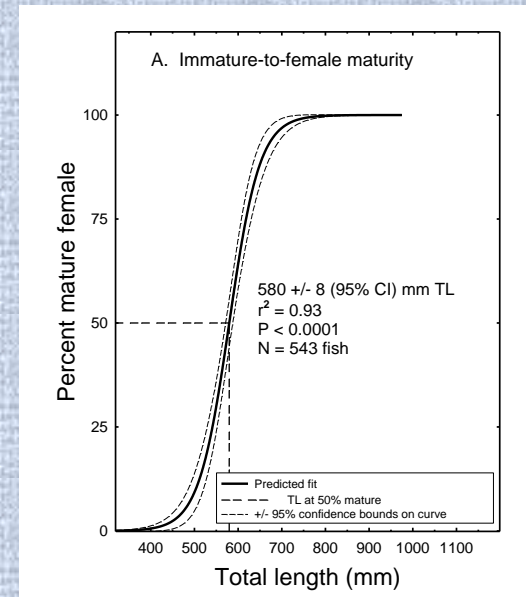
ANALYSIS OF GONADS: Gonad Histology to Determine L_{50}

Lab Analysis:

1. Histology criteria developed based on initial survey of histology slides
2. Microscopic evaluation of each slide to determine reproductive stage & maturity status
3. Analysis time: 20-40 slides/day

Data Analysis:

1. Calculate % mature per length class; mean estimates weighted by sample sizes within length classes
2. L_{50} derived from fit of logistic equation to % maturity data
3. GSI data used to determine spawning period



LIFE HISTORY INFORMATION:

Use in Stock Assessments

Length-at-Age von Bertalanffy growth equation:

1. Fundamental measure of stock productivity
2. Growth parameters are key input for Productivity-Susceptibility Analyses (PSA)
3. Required information for age-structured stock assessments

Longevity:

1. Used to evaluate population turnover and natural mortality rate for stock assessment

Reproduction:

1. Required information to calculate reproductive output of stock
2. Considered in formulating size/seasonal fishing restrictions



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STATUS OF LIFE HISTORY INFORMATION: FSSI Stocks / Top 90% of Coral Reef (CRE) Management Unit Stocks by Catch

FSSI Stocks CRE Stocks	# Stk	Samples Collectd	Samples Procesd	Samples Analyzd	VBGF	L_{50}	t_{max}
Pelagics	15	4	4	3	2	2	2
Scad-HI	2	-	-	-	2	2	2
BMUS-Sam	17	7	0	0	0	0	0
BMUS-CNMI	16	3	2	1	0	0	0
BMUS-HI	7	7	4	4	2	1	1
CRE-Sam	+30	10	0	0	0	0	0
CRE-CNMI	+30	3	2	1	0	0	0
CRE-Guam	+30	14	10	9	9	9	9
CRE-HI	+30	6	6	1	1	1	1

LIFE HISTORY INFORMATION:

Timeline of Life History Studies

Sample Collection:

1st Yr: Collection of otoliths/gonads across 12 sequential months

2nd Yr: Intensify sampling of underrepresented sizes/gender & during spawning season

Sample Processing:

~0.5-1 Yr: Sample preparation of otoliths/gonads

Lab Analysis:

~0.5-1.5 Yr: Microscope evaluation & readings; lab results for $\Delta^{14}\text{C}$ and ^{226}Ra : ^{210}Pb dating

Data Analysis:

~0.5 Yr: Life history parameters derived from data analysis

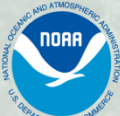


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LIFE HISTORY INFORMATION: Future Prospects

Where We Need To Be:

1. Accelerate processing and analysis of LH studies on reef & bottomfish species in American Samoa, CNMI, and Guam
2. Develop $\Delta^{14}\text{C}$ coral time series for CNMI-Guam to estimate longevity & validate ages of long-lived reef and bottomfish
3. For Hawaii, more pelagic, bottomfish, and reef fish LH studies



LIFE HISTORY INFORMATION: Future Prospects

Realistic Future Progress:

Limited progress in increasing internal/external capacity to conduct life history studies:

1. Program has 2 senior biologists, 1 junior biologist, 1 tech available for current life history studies
2. No new Life History Program staff hiring since 2009
3. Future Bio-Sampling budgets unlikely to increase
4. Mentoring 2 NOAA staff in Guam/CNMI and 1 student
5. Attempting to contract mainland otolith lab for age & growth analyses; local university lab will take time

